

# Qualification and Implementation of HVOF Coatings on H-60 Main and Tail Landing Gear



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# UH-60L/M HVOF Coatings Qualification for Landing Gear Systems

- **Program Objective**

- Replace EHC plating with an HVOF coating on main and tail landing gear systems
- Coatings must not detract from component performance
- Main driver of this program are environmental and health concerns and field reliability

- **Program Status**

- Completed an industry trade study
- Selected candidate coating for EHC replacement
- Proposed an approach for qualification to customer
- Testing activities to begin this year



# UH-60L –Chromium Plated Landing Gear Components

	Component Nomenclature	Base Material	Heat Treatment
<b>Main Landing Gear Components</b>	Main Landing Gear Piston	4340 per MIL-S-8844	200KSI
	Main Landing Gear Piston and Cylinder	4340 per MIL-S-8844	200KSI
	Main Landing Gear Axle	4340 per MIL-S-8844	260 – 280 KSI
	Drag Beam Pivot Pin	4340 per MIL-S-8844	260 – 280 KSI
<b>Tail Landing Gear Components</b>	Tail Landing Gear Fork	7175-T74 per AMS 4149	T74
	Tail Landing Gear Axle	4340 per MIL-S-5000	180 KSI
	Tail Landing Gear Piston	7075-T73 per QQ-A-367	T73
	Tail Landing Gear Piston and Cylinder	7075-T73 per QQ-A-367	T73



# UH-60L HVOF Landing Gear Team Members

- SAC Implementation Team
  - Landing Gear Design
  - Structures
  - Materials and Process
  - Reliability and Maintainability
  - ILS
  - Ground Test
  - Purchasing
  - Programs
- Suppliers Team
  - Landing Gear Assembly
  - Coating Suppliers
  - Seal Suppliers
- Hard Chromium Plate Alternatives Team (HCAT)



# **Airworthiness Qualification Requirements for the Qualification of High Velocity Oxygen Fuel (HVOF) Tungsten Carbide Coating on the UH-60 Landing Gear Shock Struts Pistons and Cylinders (TN 11561) 25 Mar 05**

1. Fatigue life of HVOF must be equivalent to chromium plated component. Substantiation is by analysis or test.
2. Tensile, yield strength, % e, coating adhesion, pitting corrosion, SCC properties of the HVOF coupons shall demonstrate equivalency to chromium plated coupons.
3. Applied stress and strain at the onset of spalling of the HVOF coating must exceed the maximum service stress and strain.
4. Seal life and leakage performance of HVOF must be equivalent or better than chromium.
5. The finished diameter of the coated part must meet the current drawing requirements.



# HVOF Program Tasks

1. Collect Existing Data
  - SAC
  - HCAT
2. Analysis of Data
3. Select Candidates
4. Publish White Paper to Substantiate Selection
5. Sikorsky Internal Process Certification
  - Fatigue
  - Residual Stress
  - Strain Threshold
  - Adhesion
  - Microstructure
  - Hardness
- Extensive reference to HS15580
6. First Article Testing
  - Metallurgical
  - Distortion
  - Adhesion
  - Corrosion
  - Geometrical effects
7. Structural Analysis
  - Fatigue life
  - Maximum service stress and strain
8. Structural/Wear (Ground) Analysis



## Materials Testing

# Coupons

- Residual stress
- Strain to Fracture
  - Onset of cracking
  - Onset of spalling
- Adhesion
- Microstructure
- Hardness
- Metallurgical exam

# Component

- 1<sup>st</sup> article destructive exam
- Metallurgical exam
- Distortion evaluation
- Adhesion
- Corrosion (primarily at interface with other coatings)
- Hardness
- Substrate heating effect



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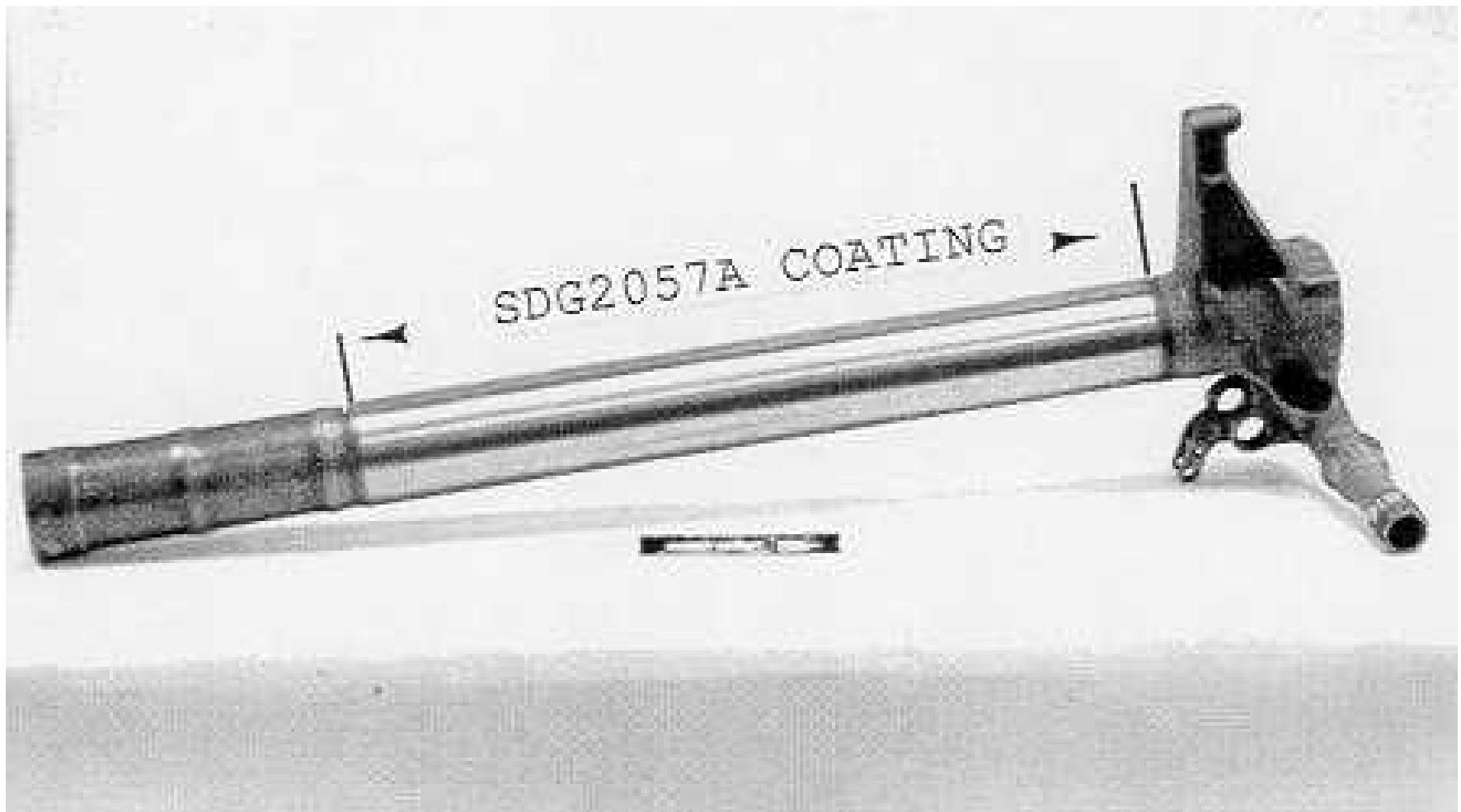
SH-60B SEAHAWK



Tail Landing Gear Piston



## SH-60B TLG Piston, Cleveland Pneumatic PN 2012C4, Base Metal: 300M Steel, Coated with SDG2057 WC-CoCr





# Qualification Test matrix for Navy H-60

## Tail Gear Piston

- Coating adhesion
- Tensile
- Fatigue (HCF)
- Fatigue (LCF)
- Cyclic stress/strain
- Metallurgical
- Wear test (bench scale)
- Drop test (full scale)
- Corrosion
  - Open section
  - Crevice testing
- First article destructive evaluation/validation
- NAVAIR review
- Lead-the-fleet testing



# Qualification Test Matrix for UH-60 tail

## Landing Gear Fork

- Adhesion (coupon)
- Metallurgical (coupon & full scale)
  - hardness
  - porosity/uniformity
  - heat/mechanical effect on substrate
- Fatigue (coupon)
- Fatigue after exposure to salt fog (coupon)
- Wear test
- Corrosion testing (full scale)
- Army AMCOM review
- Lead-the-fleet testing